Survey of TIDE "Lobal Wind" Observations, Part 2

Mike Liemohn, TIDE Telecon, January 7, 2004

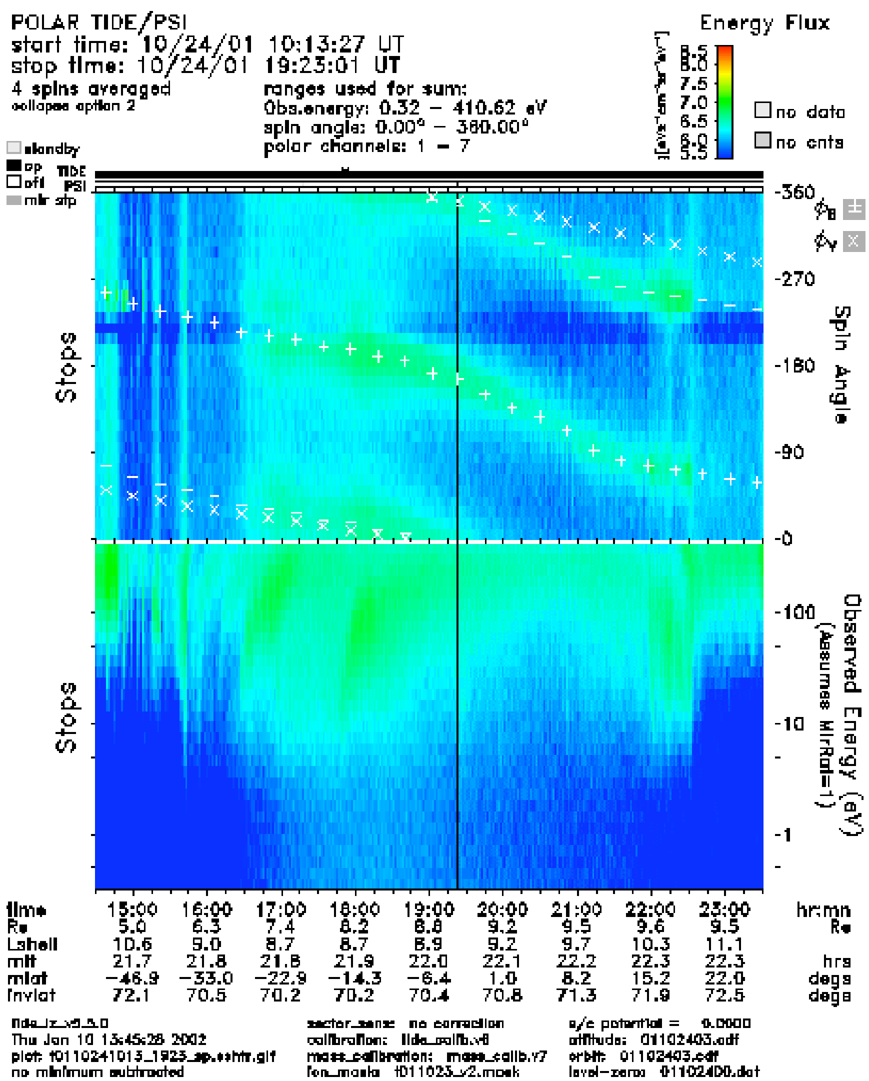
With many thanks to Tom Moore

Lobal Winds: ubiquitous beams of cold plasma in the magnetotail lobes

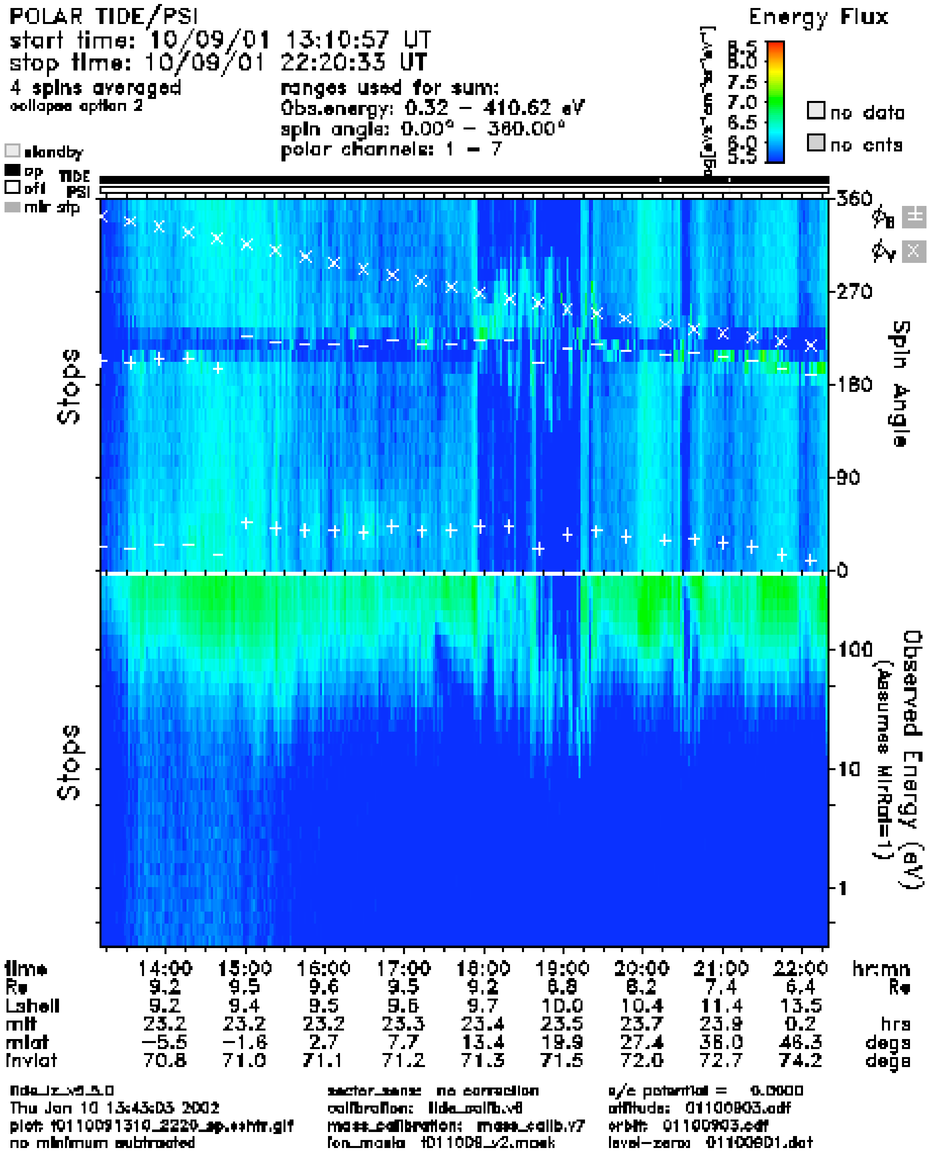
Common features:

- Bi-directional streaming near the plasma sheet
- Uni-directional streaming at higher magnetic latitudes
- Density is very small (< 0.01 cm^{-3})
- Bulk-flow energy is ~100 eV (100-200 km/s for H^+)
- Temperatures are small ($T_{\parallel}, T_{\perp}$ < 10 eV)

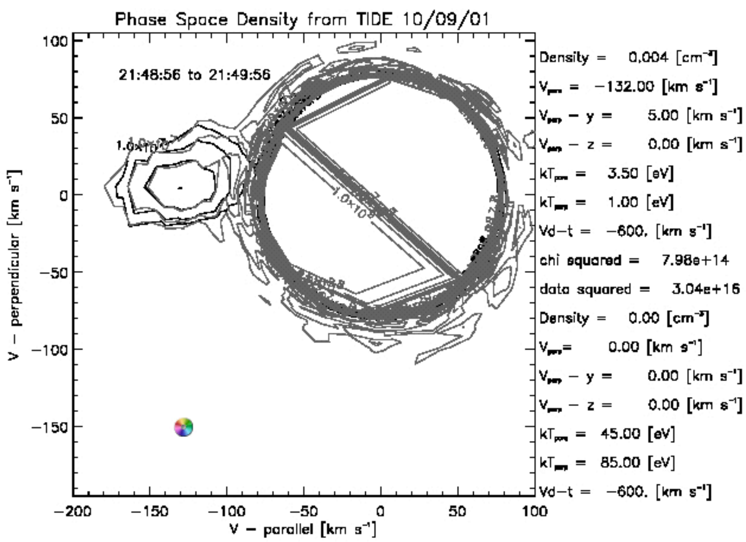
Example of a thick neutral sheet crossing (from Tom's ICS-6 talk):



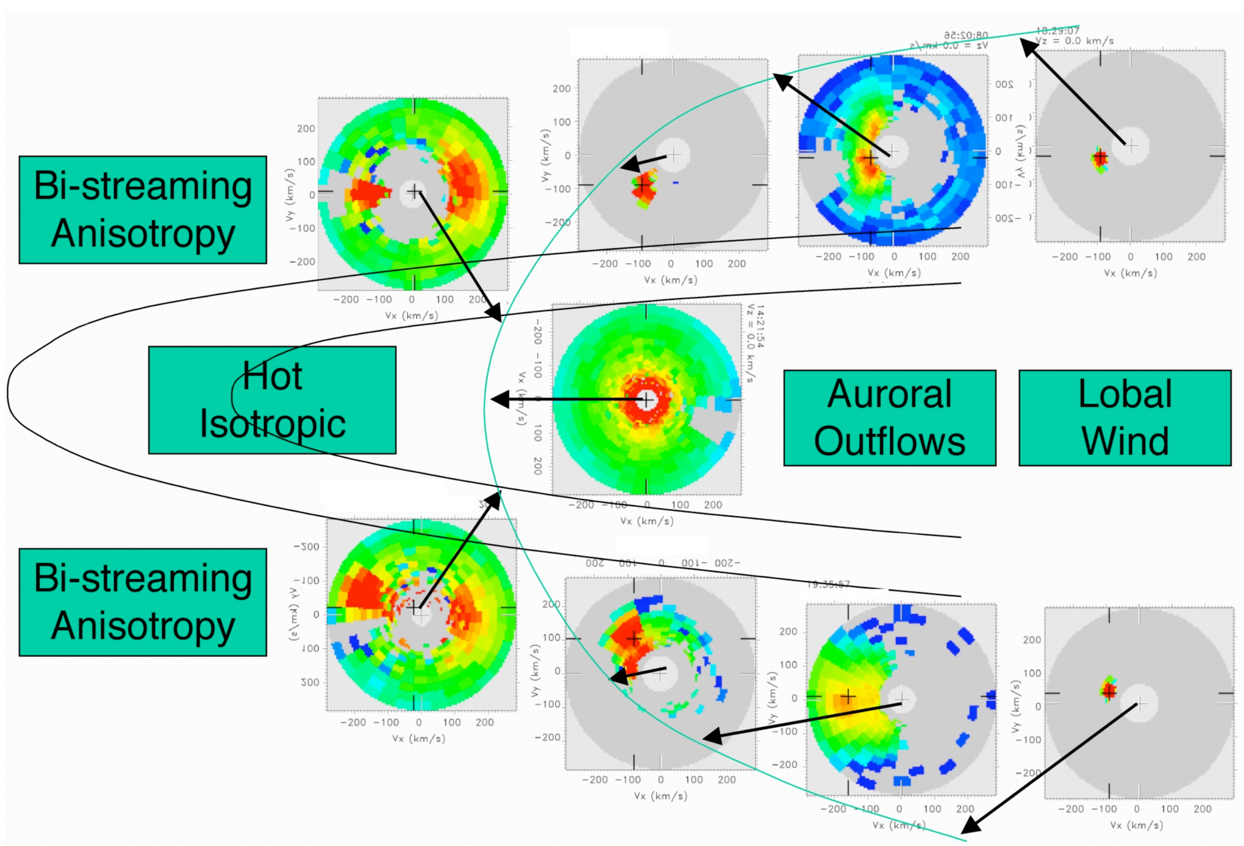
Example of a thin neutral sheet crossing (from Tom's ICS-6 talk):



Example of a phase space density plot (from Tom's ICS-6 talk):



Tom's schematic summary of the observations (from Tom's ICS-6 talk):



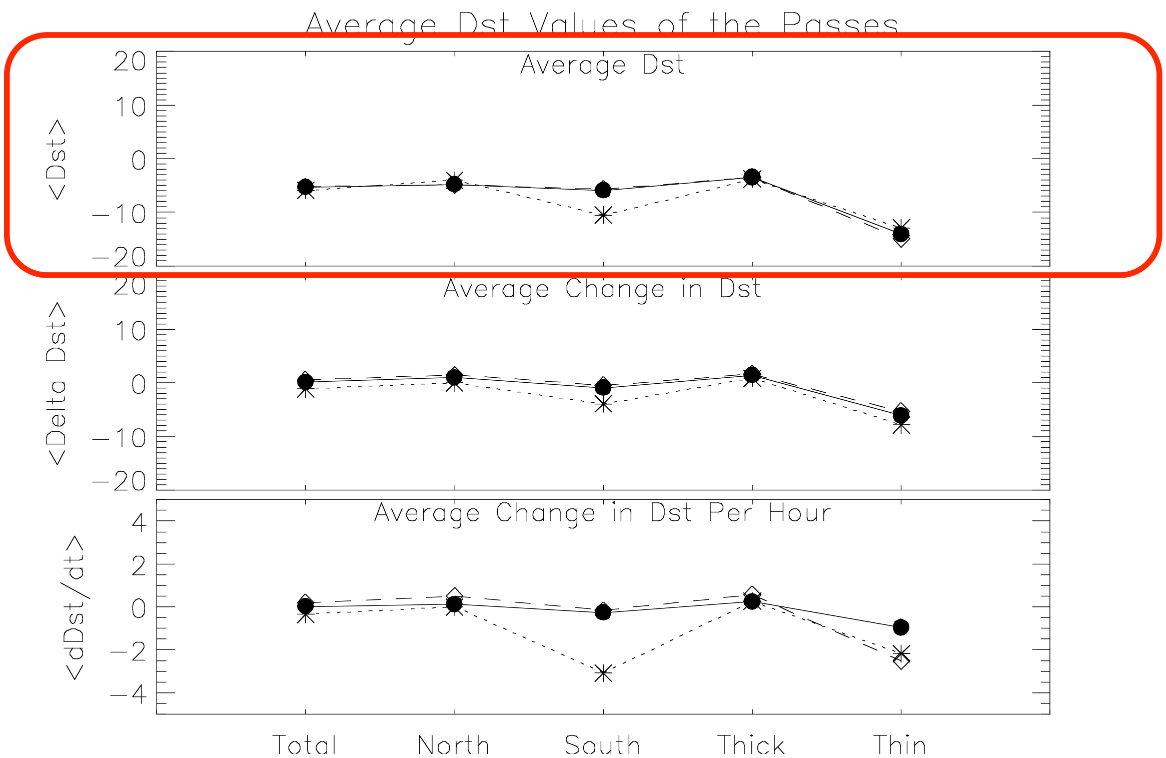
Survey of Lobal Winds in the TIDE Database:

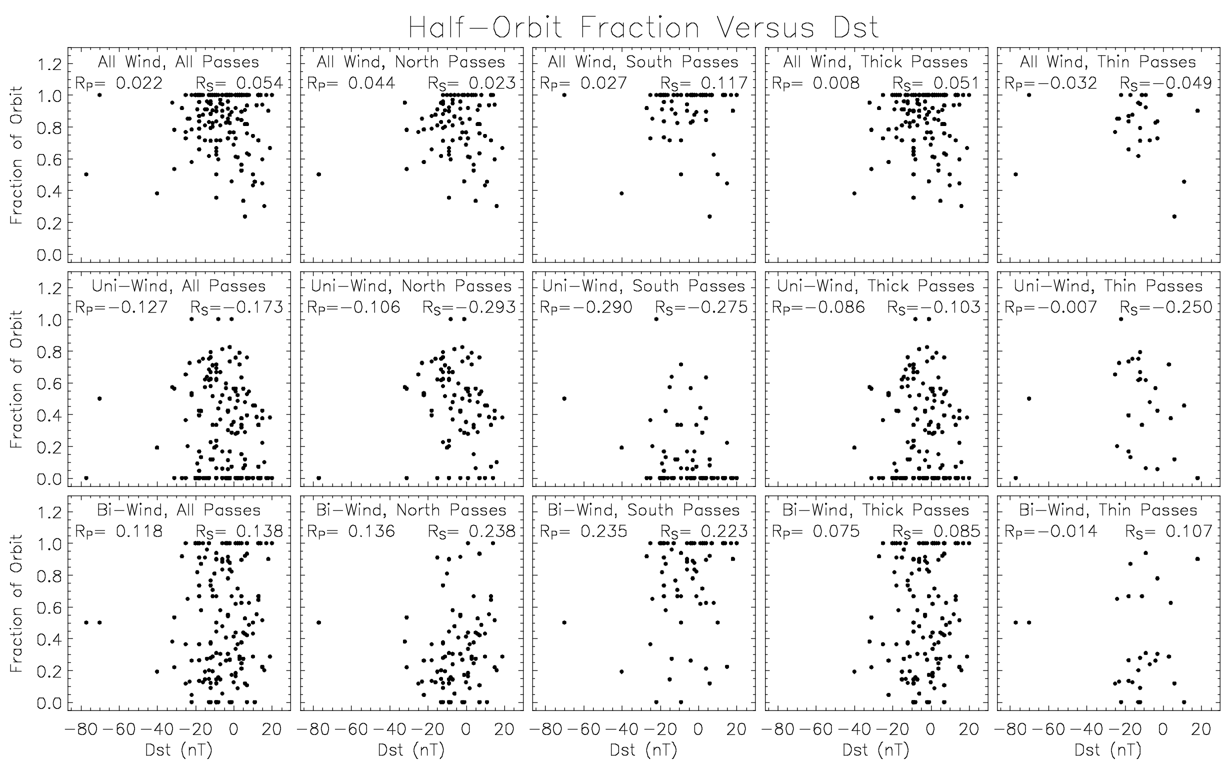
So far: July 1 – October 23, 2001
Number of half-orbits in survey: 200
MLT range in survey: 22.3 to 5.7 h (plasma sheet crossing)

Objective: Look for lobal winds in each half-orbit (north, south)
Criteria:
- Small background radiation contamination (some half-orbits omitted)
- Identifiable by eye in the summary plots
- Half-orbit begins either:
  - at transition to rammed cold plasma at high latitudes
  - beyond the radiation belt contamination interval
- Half-orbit ends at neutral sheet

Parameters in survey database:
- Date, start time, stop time, and duration of the half-orbit pass
- North/south flag
- Thick/thin neutral sheet flag (thin = less than 1 hour for field to flip)
- MLT of neutral sheet endpoint of half-orbit
- Unidirectional wind flag
- Duration of unidirectional wind
- Bidirectional wind flag
- Duration of bidirectional wind
- Average Dst during half-orbit pass
- Change in Dst (start-time Dst minus stop-time Dst)
- Change in Dst per hour
- Average SW density
- Average SW velocity
- Average SW dynamic pressure
- Average IMF By
- Average IMF Bz
- Average IMF Bt (square root of $By^2 + Bz^2$)
- Average clock angle
- Average SW Ey
- Average Kan and Lee E-field
- Average density, velocity, and temperature of the lobal wind (in progress)

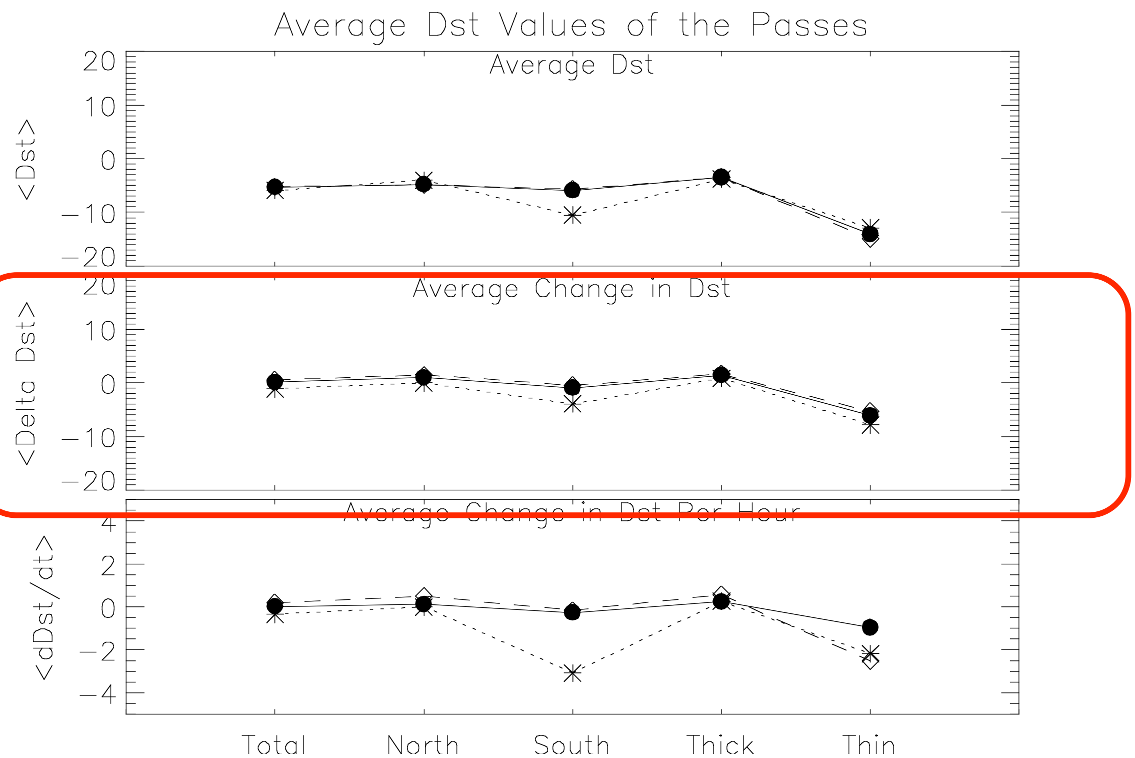
Relationship With Dst Value During the Half Orbit:

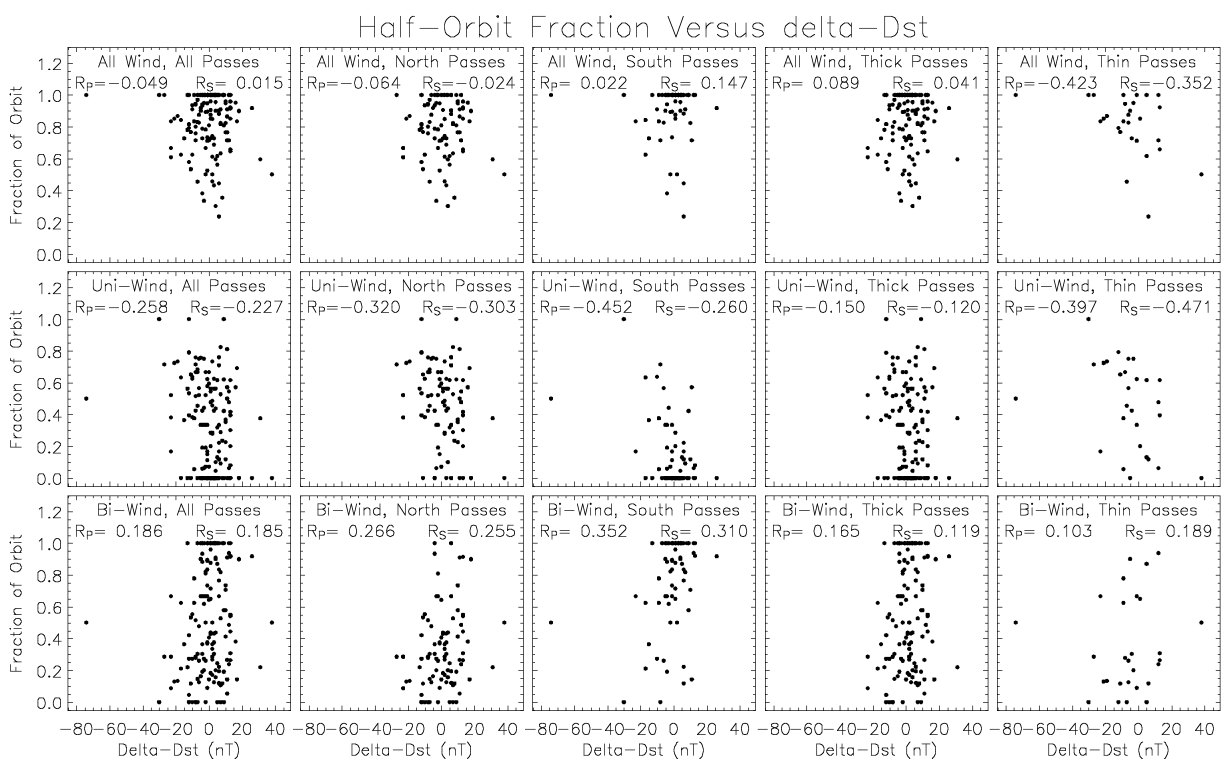




Finding: <u>slight</u> correlative relationship between Dst and lobal wind occurrence rate
Trend: Negative Dst intervals (storms) result in unidirectional winds

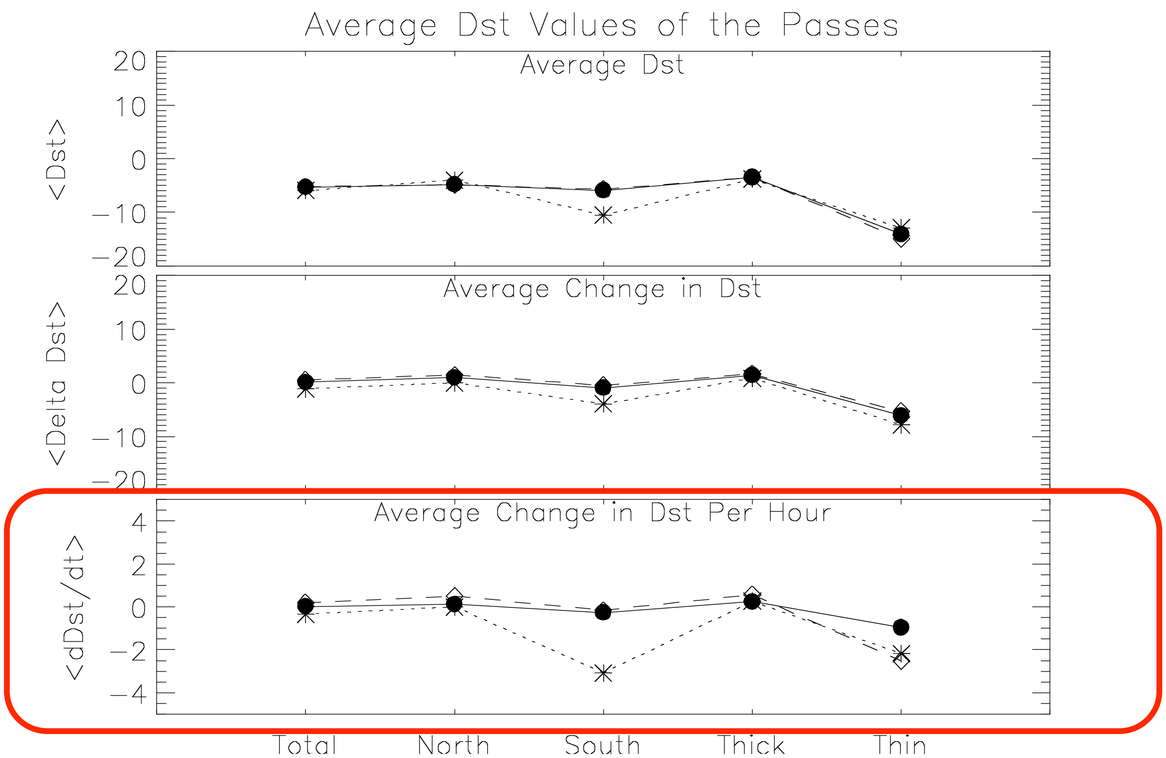
Relationship With the Net Change in Dst During the Half Orbit:

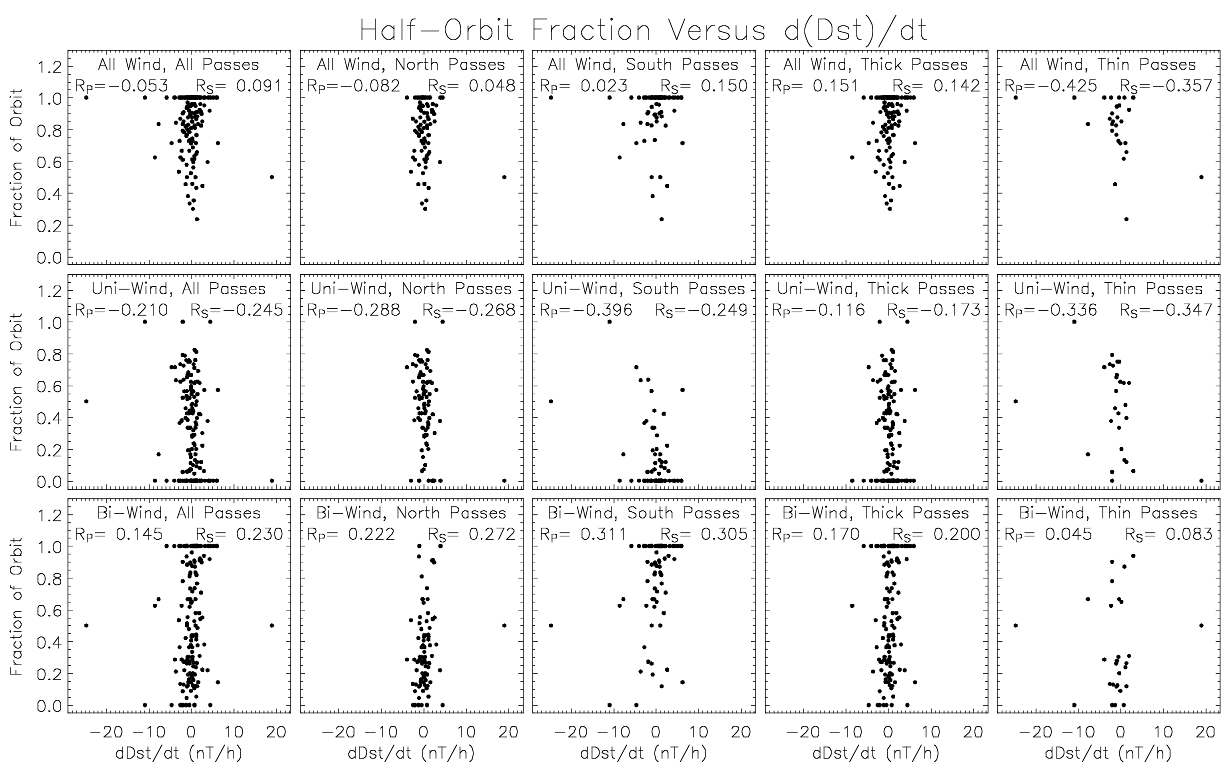




Finding: <u>slight</u> correlative relationship between delta-Dst and lobal wind occurrence rate
Trend: Negative delta-Dst intervals (main phases) result in unidirectional winds

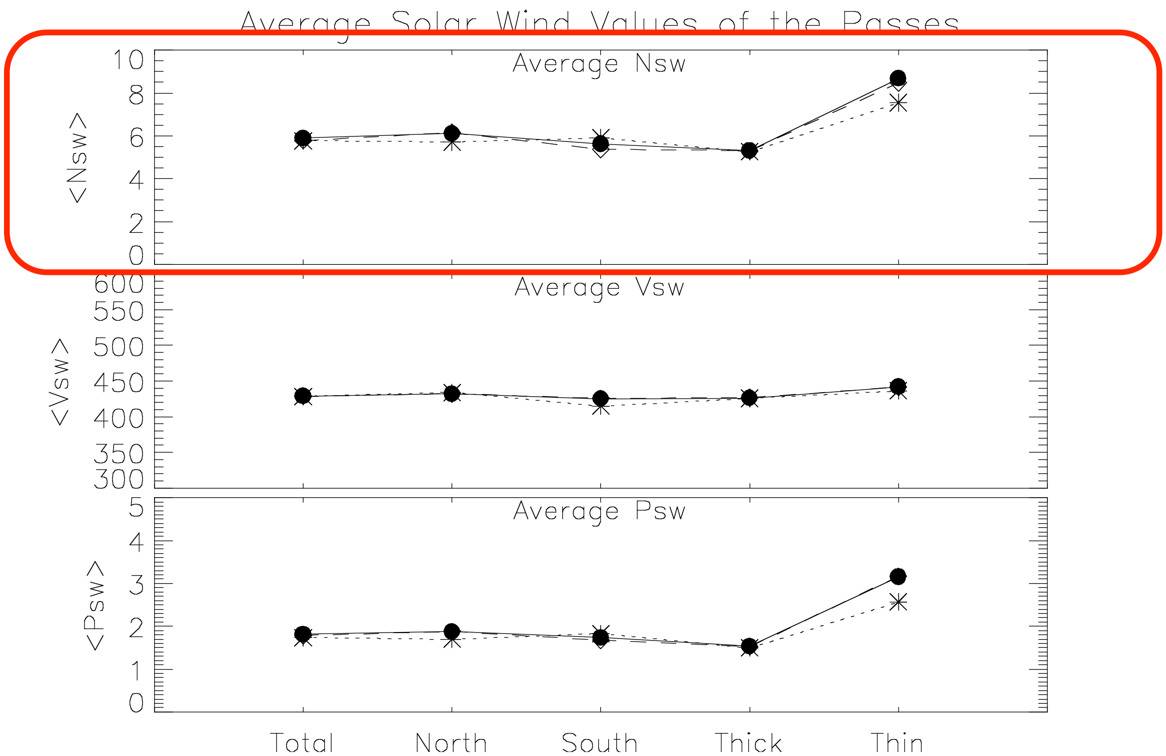
Relationship With Rate of Change in Dst During the Half Orbit:

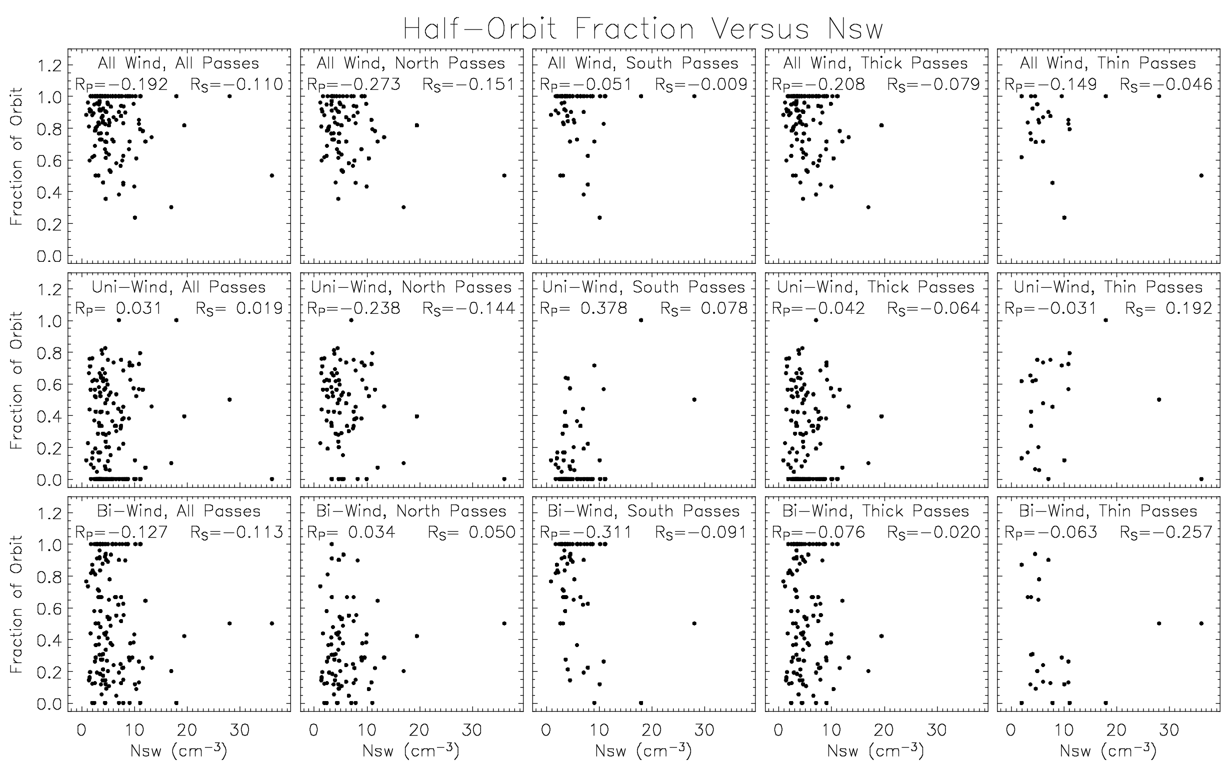




Finding: <u>slight</u> correlative relationship between dDst/dt and lobal wind occurrence rate
Trend: Negative dDst/dt intervals (main phases) result in unidirectional winds

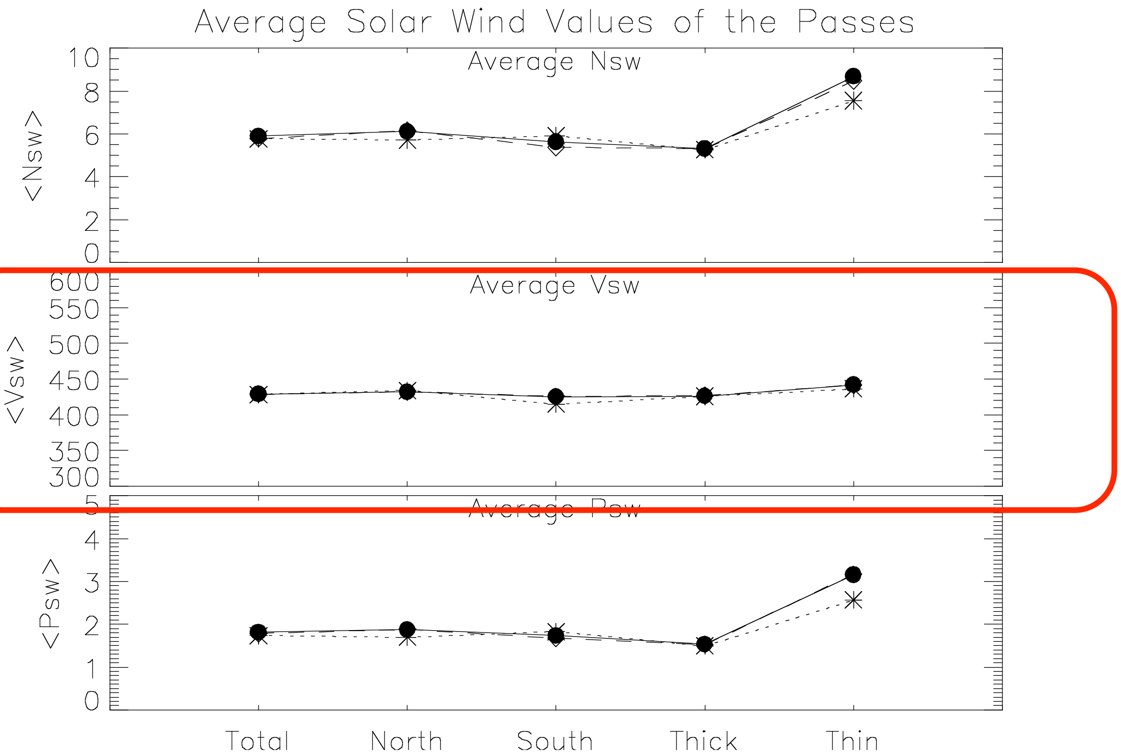
Relationship With Solar Wind Density During the Half Orbit:

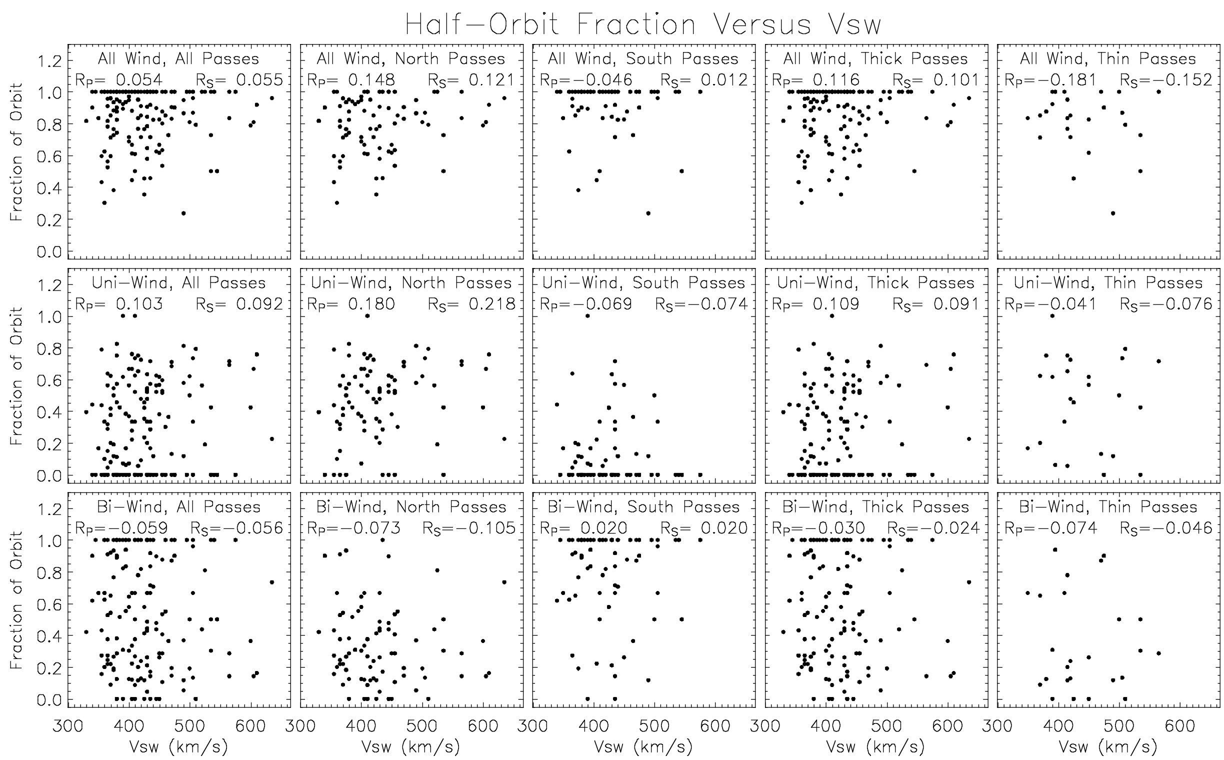




Finding: <u>no</u> correlative relationship between Nsw and lobal wind occurrence rate

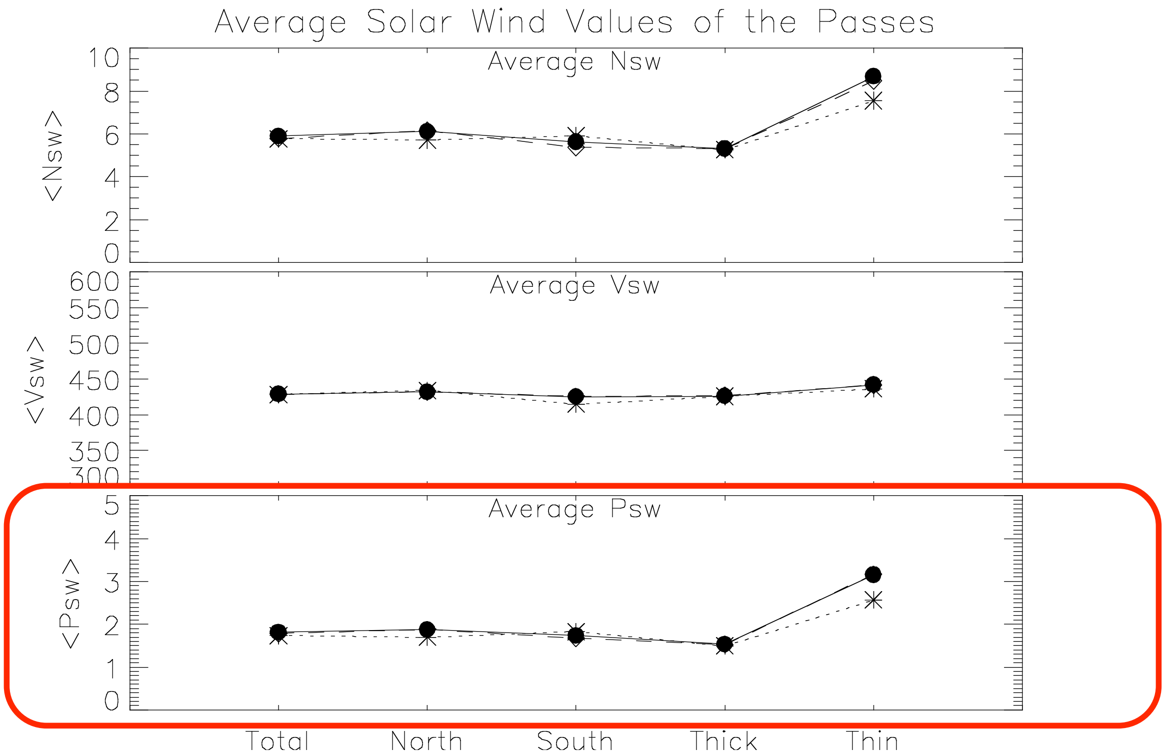
Relationship With Solar Wind Velocity During the Half Orbit:

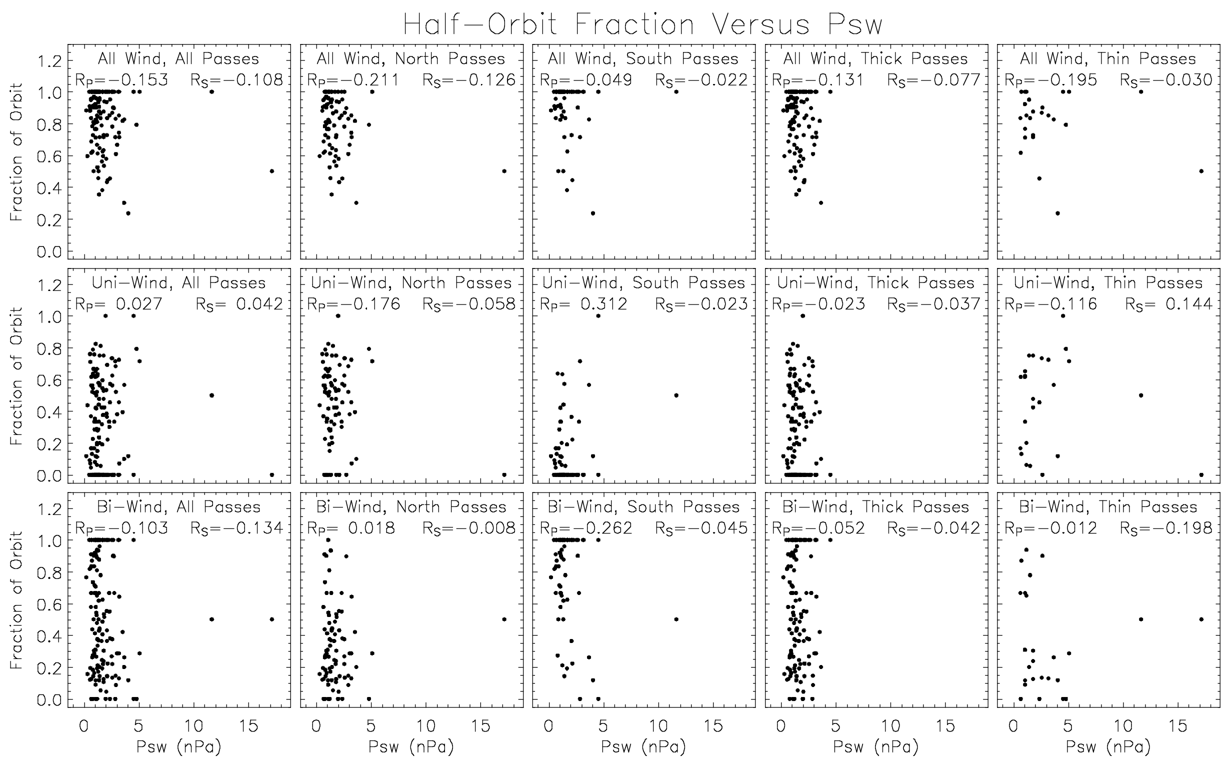




Finding: no correlative relationship between Vsw and lobal wind occurrence rate

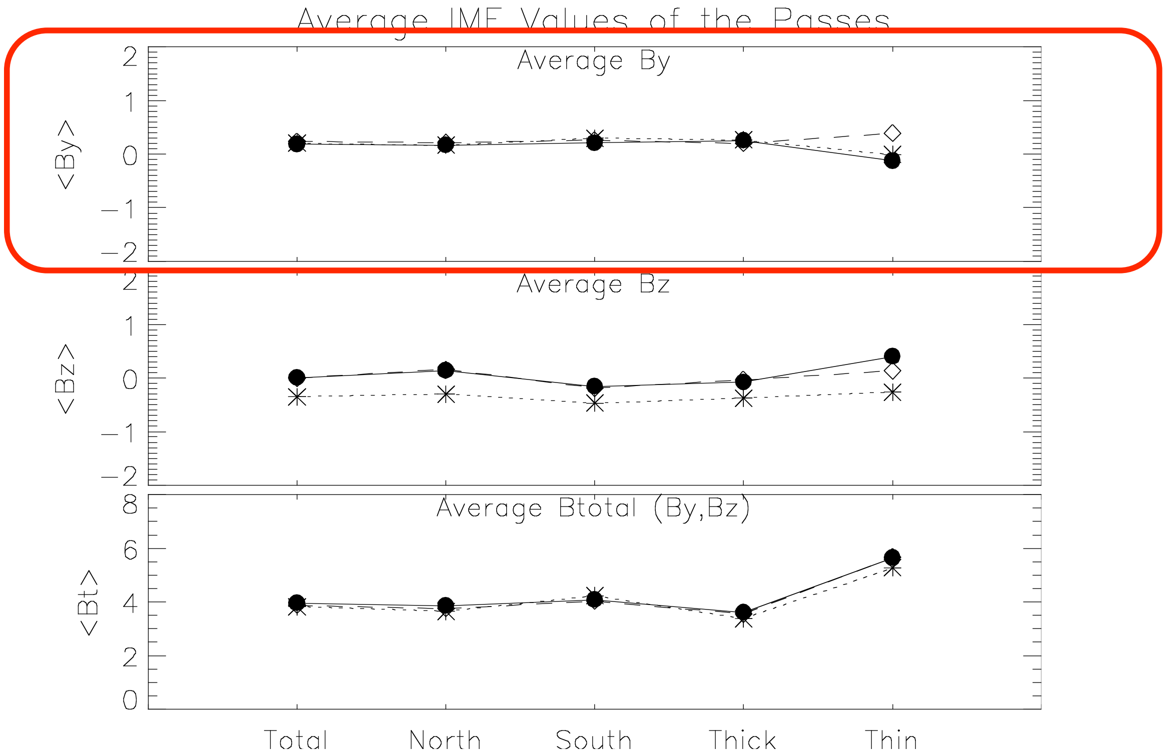
Relationship With Solar Wind Dynamic Pressure During the Half Orbit:

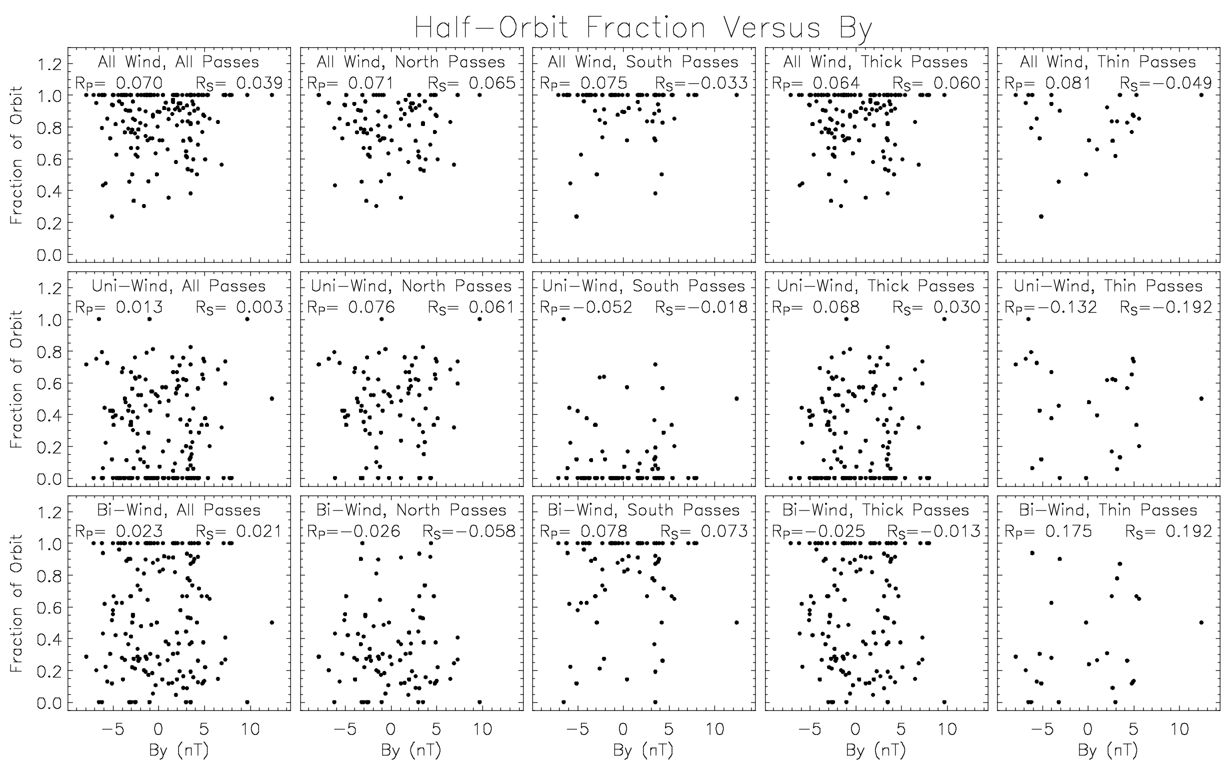




Finding: <u>no</u> correlative relationship between Psw and lobal wind occurrence rate
Trend: If anything, high Psw intervals (sheaths) result in few lobal winds (for top row, R<0)

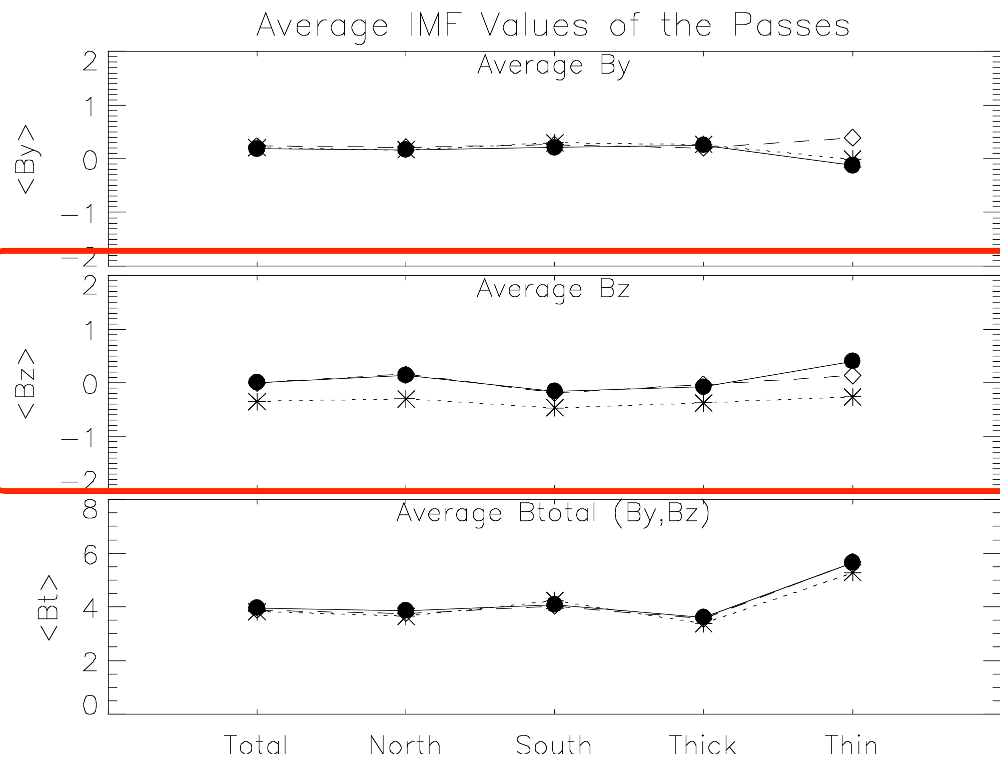
Relationship With IMF By During the Half Orbit:

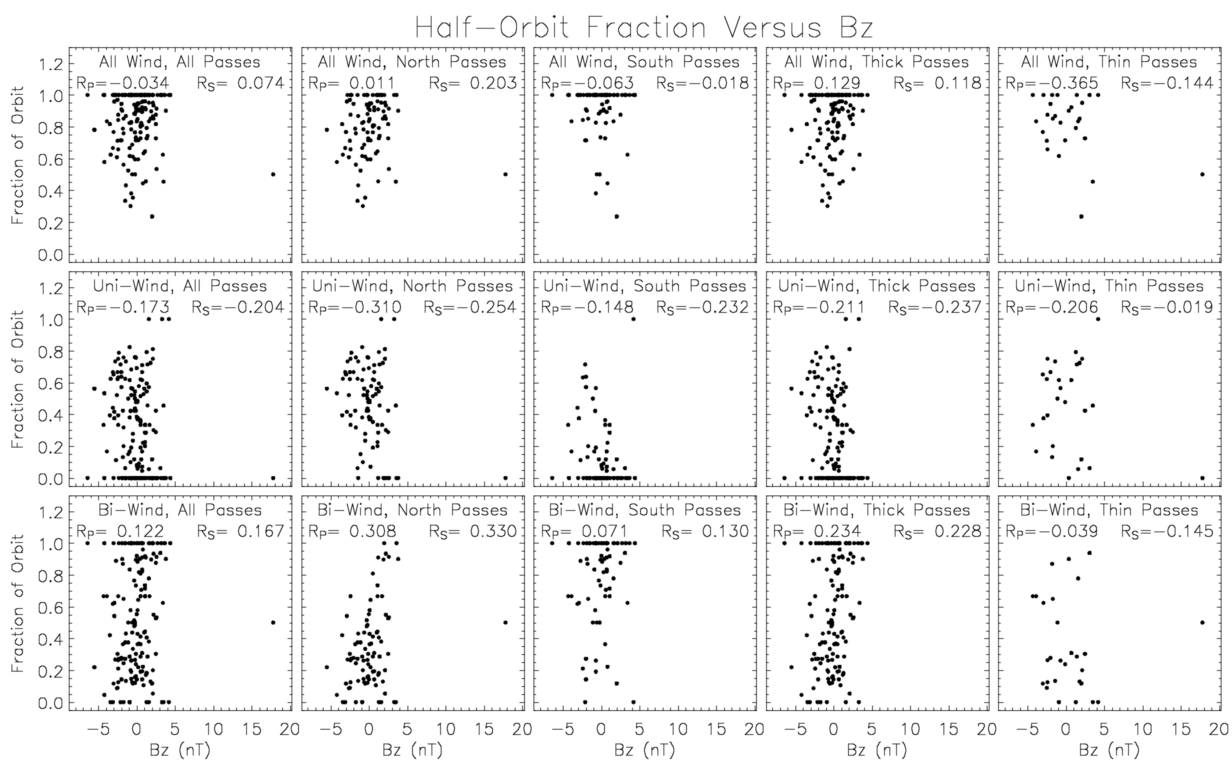




Finding: <u>no</u> correlative relationship between By and lobal wind occurrence rate

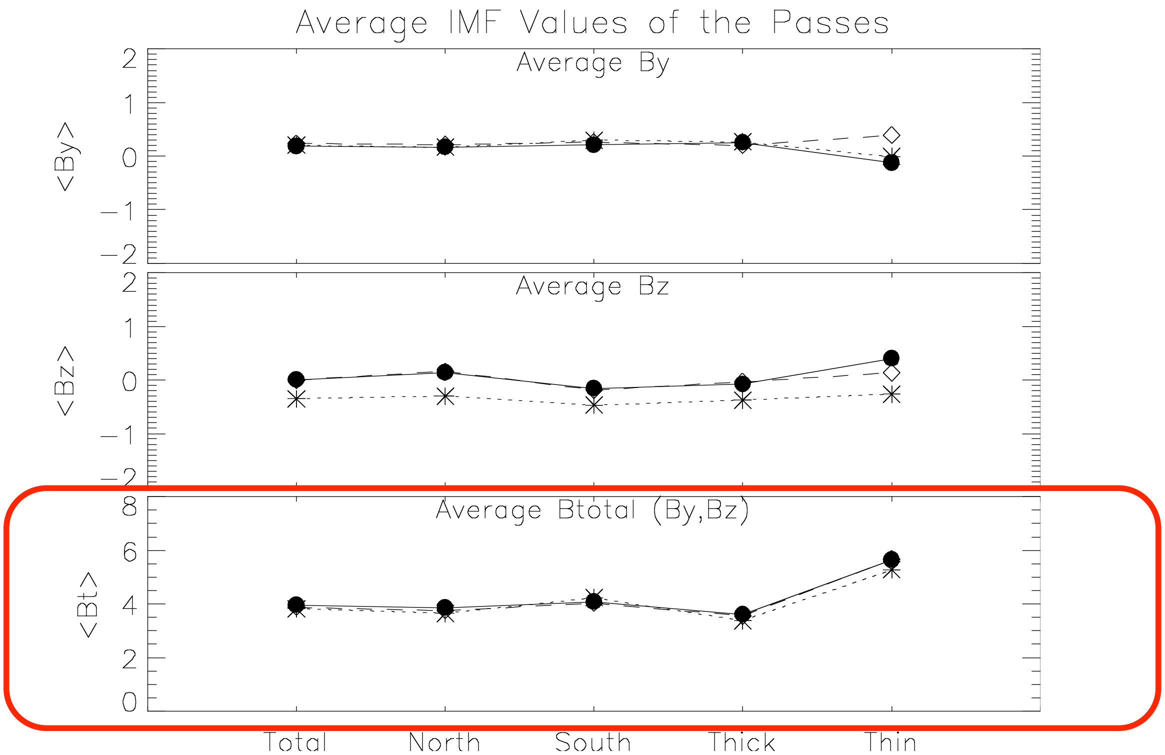
Relationship With IMF Bz During the Half Orbit:

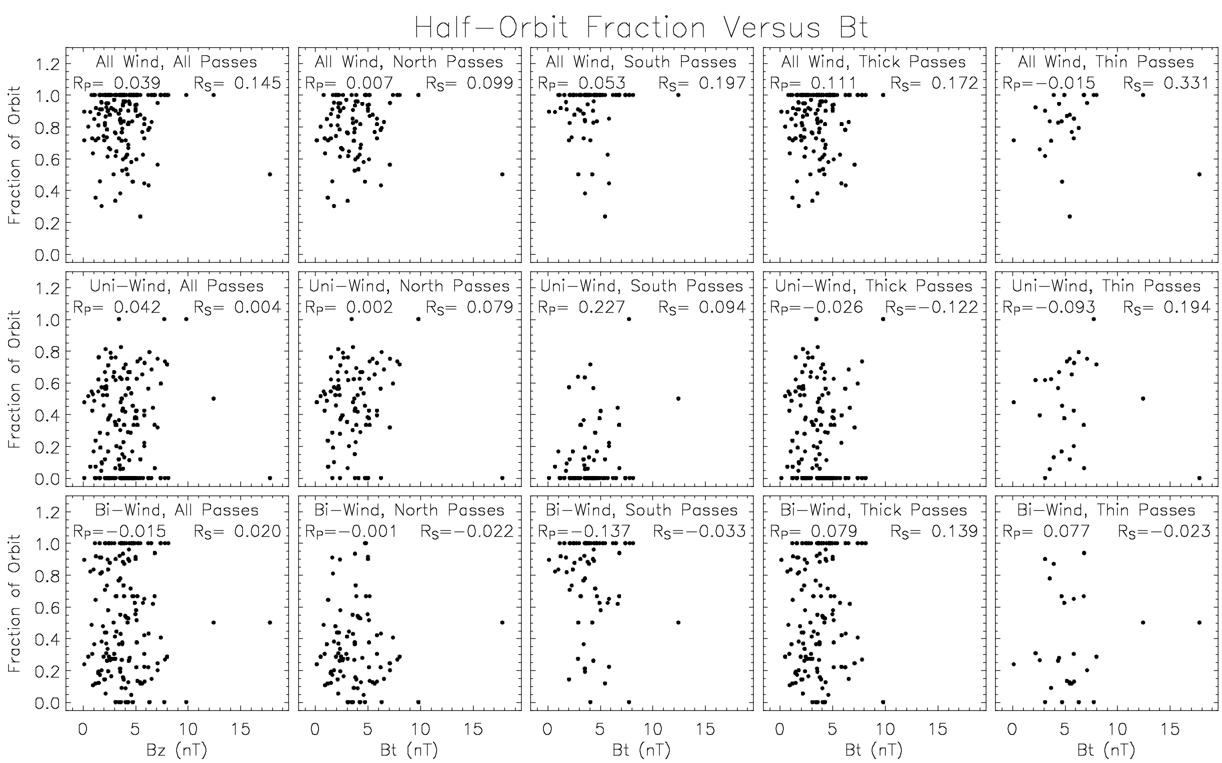




Finding: <u>slight</u> correlative relationship between Bz and lobal wind occurrence rate
Trend: Negative Bz intervals (merging times) result in unidirectional winds

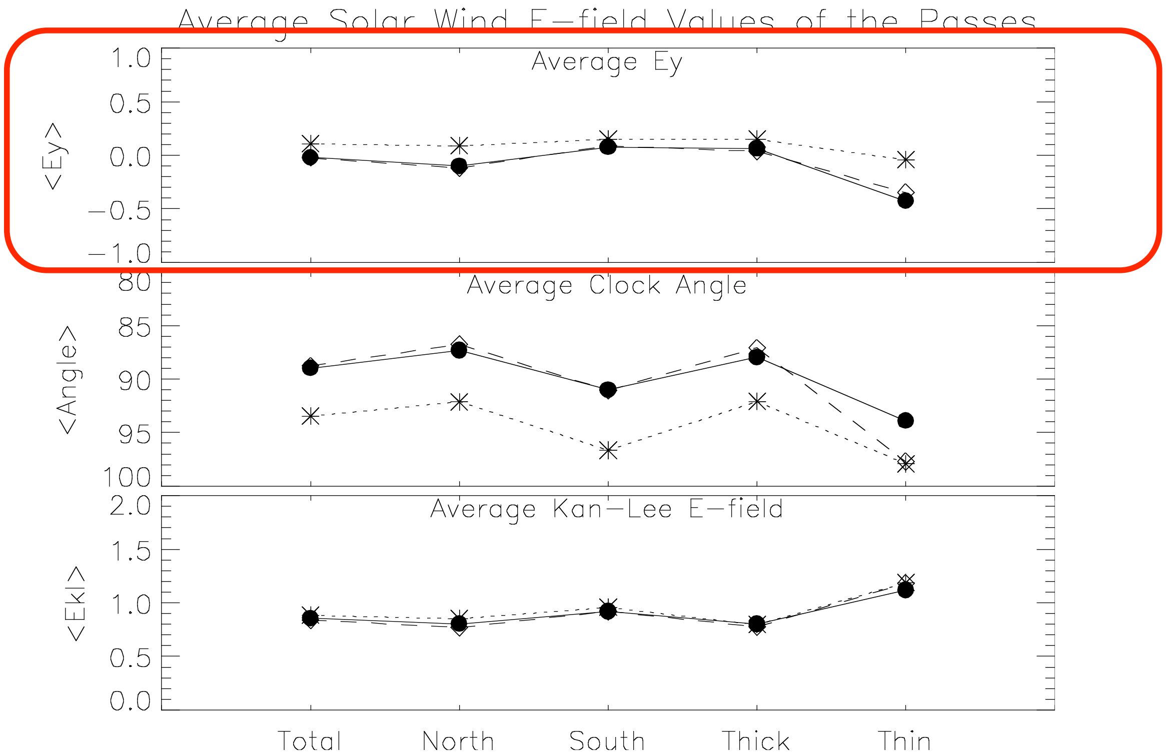
Relationship With IMF Bt During the Half Orbit:

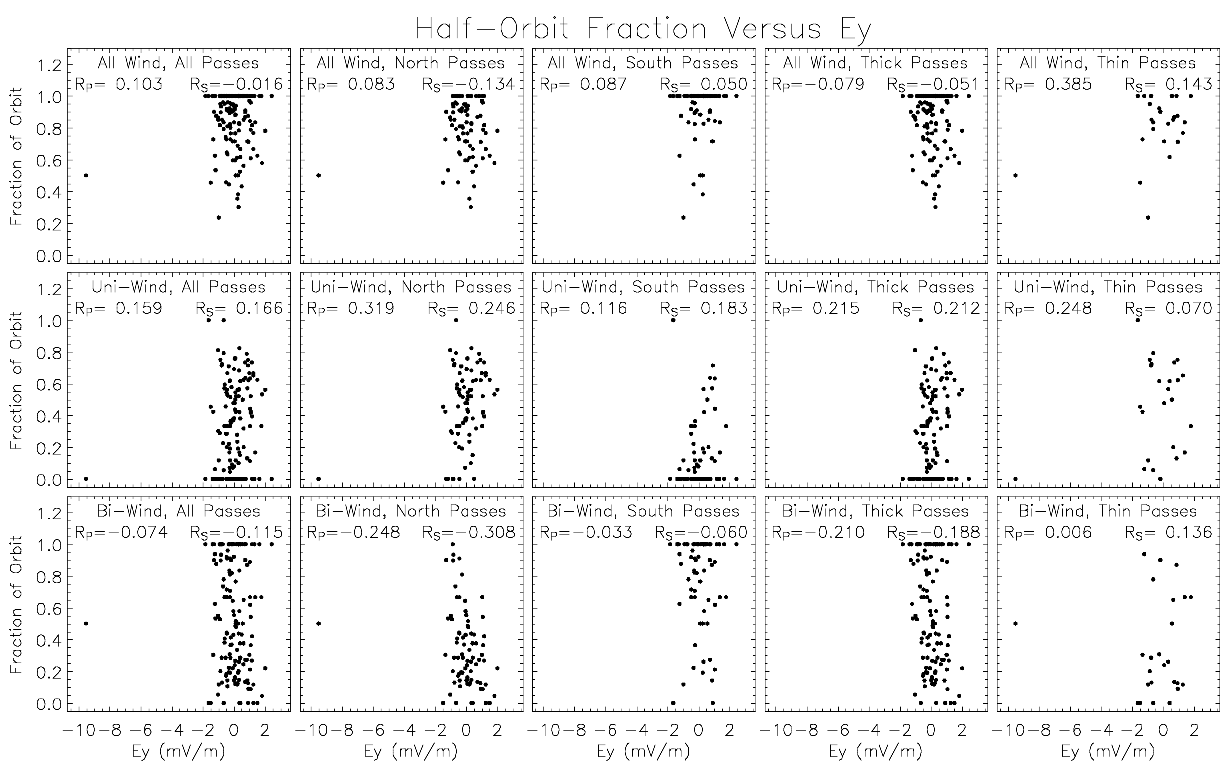




Finding: <u>no</u> correlative relationship between Bt and lobal wind occurrence rate

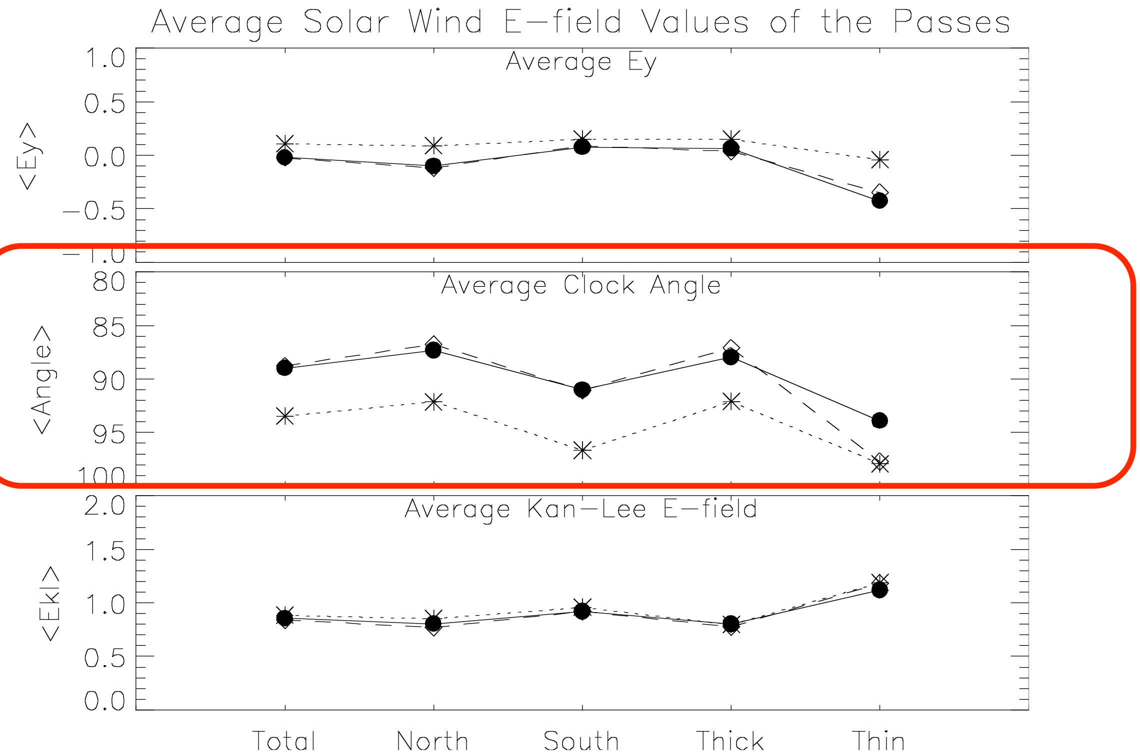
Relationship With Solar Wind Ey During the Half Orbit:

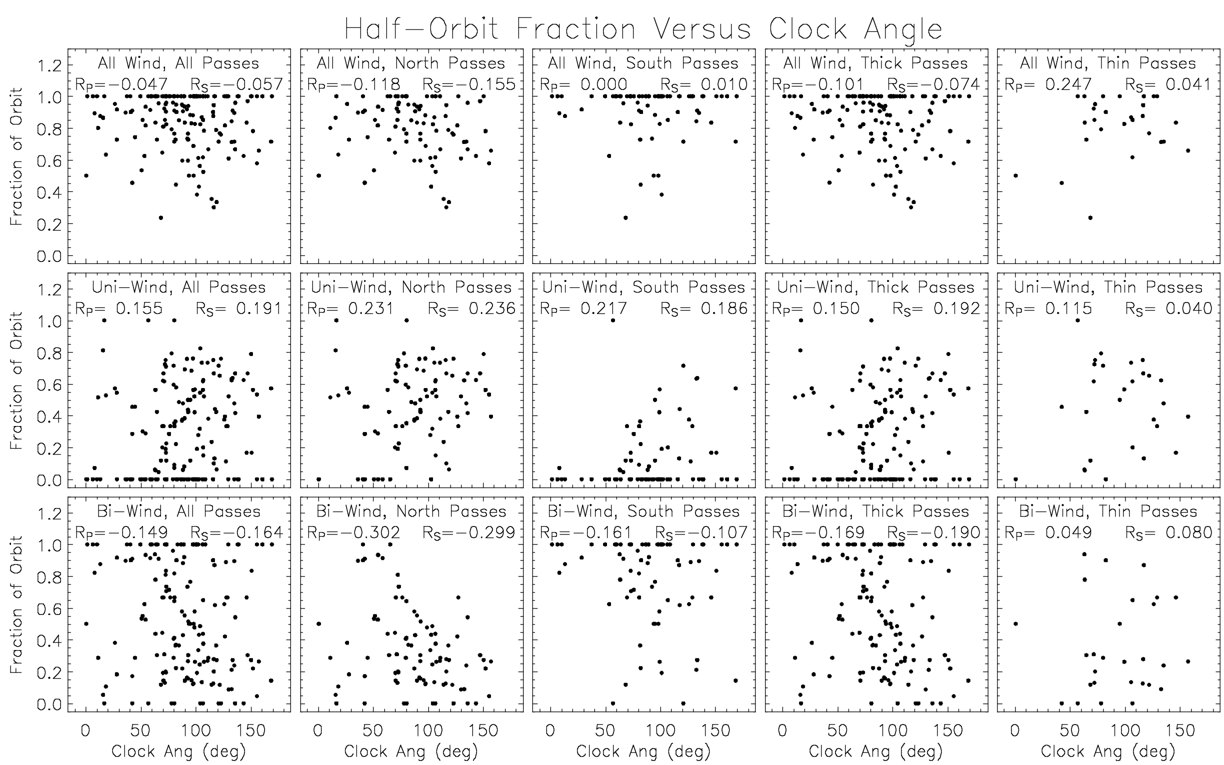




Finding: slight correlative relationship between Ey and lobal wind occurrence rate
Trend: Positive Ey intervals (SW-coupling times) result in unidirectional winds

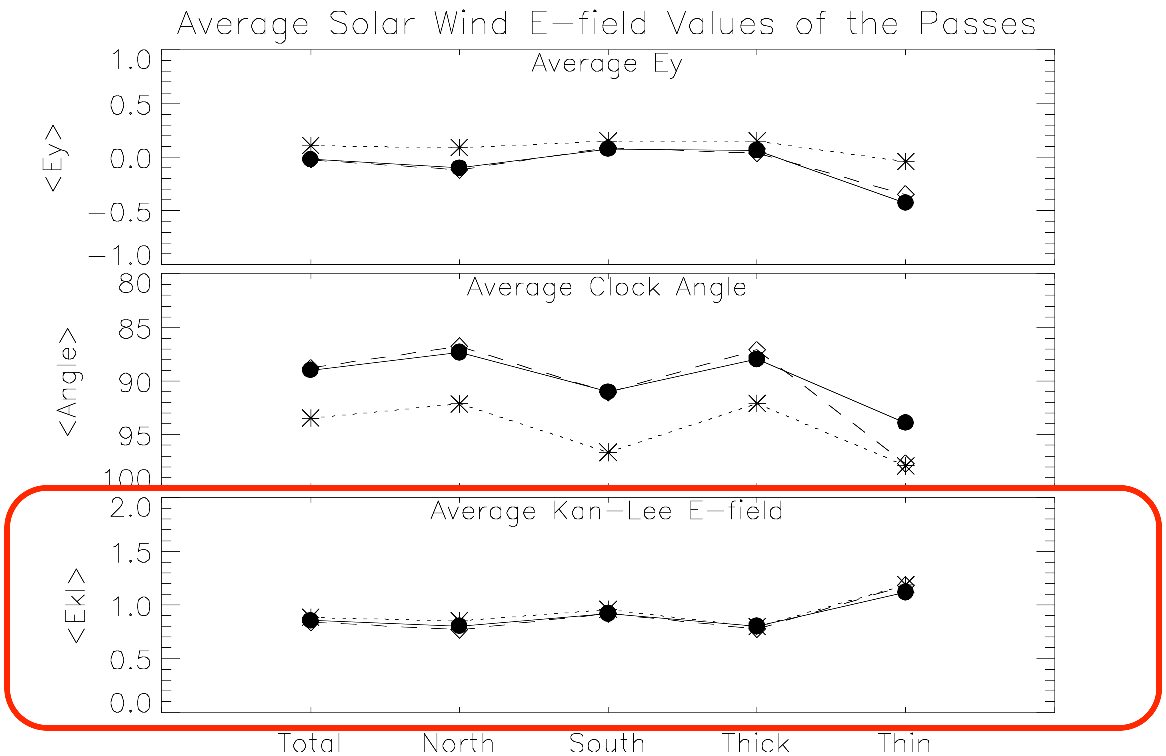
Relationship With IMF Clock Angle During the Half Orbit:

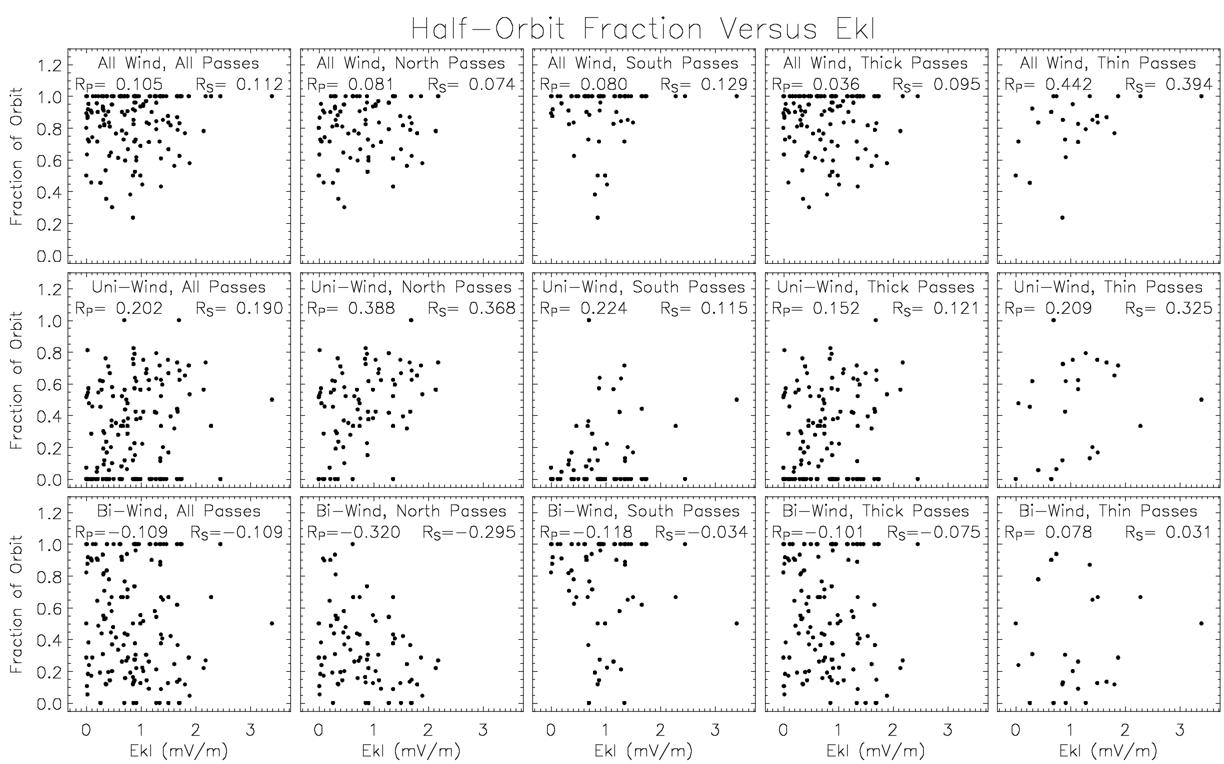




Finding: slight correlative relationship between Clock-angle and lobal wind occurrence rate
Trend: Large clock-angle intervals (Bz<0) result in unidirectional winds

Relationship With Solar Wind Kan-Lee E-Field During the Half Orbit:





Finding: <u>possible</u> correlative relationship between Ekl and lobal wind occurrence rate
Trend: Large Ekl intervals (SW-coupling times) result in unidirectional winds

Summary of Findings

Ubiquitous is an understatement
    Every half-orbit in database contains a lobal wind measurement
    80% of time in these half-orbits contain lobal wind measurements
    Range is 20% to 100% of time during any given half orbit

Trends from the initial analysis
    South passes are closer to Earth and at lower magnetic latitudes, so more bi-dir winds
    North has a smaller time percentage because of high-latitude portions of passes
    South has shorter average time than north because of orbit geometry
    Thin sheet times happen during negative Dst and decreasing Dst (active times)
    Thin sheet times happen during higher Nsw/Psw (pressure hits)
    Thin sheet times happen during higher Bt (but not necessarily $Bz < 0$)
    Unidir wind times happen during lower Dst for south passes (storms)
    Unidir wind times happen during $Bz < 0$, clock angle > 90, $Ey > 0$ (SW-Mag coupling)

Trends from the newly presented analysis
    During quiet conditions, we are more likely to see bidirectional lobal winds
    During disturbed conditions, we are more likely to see unidirectional lobal winds
    "Disturbances" are "best" categorized by E_kl, but other parameters also work
    These trends are weak at best, and any type of wind can be seen for any condition

    Conclusion #1: Lobal winds are blowing regardless of geomagnetic activity
    Conclusion #2: A disturbed magnetosphere prevents obs. of plasma sheet penetration

    Hypothesis #1: During disturbances, the lobal winds feed the plasma sheet
    Hypothesis #2: During disturbances, magnetic topology is changed to favor uni-dir obs.

Things to do:
    Complete the MLT coverage in the database
    Complete the moments calculations (ugh!)
    Look for trends in moments versus geophysical parameters
    Write it up

Question for the group:

Do I need to complete the moments calculations?

Reasons FOR:
    -- More robust lobal wind "characteristic" values
    -- Scatter plots with density or flux might be revealing
Reasons AGAINST:
    -- More numbers may not change the existing characteristic values very much
    -- Time, time, and more time will be needed (how soon do you want this submitted?)